Seismic Monitoring of the Shumagin Seismic Gap, Alaska

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Investigations

Seismic data from the Shumagin seismic network (Figure 1) were collected and processed to obtain digital waveforms, origin times, hypocenters, and magnitudes for local and regional earthquakes. The data are used for earthquake source characterization, determination of earth structure, studies of regional tectonics, analysis of possible earthquake precursors, and seismic hazard evaluation. Yearly bulletins are available starting in 1984 through 1990.

Results

Shumagin network data were used to locate 137 earthquakes from January 1 to June 30, 1990, bringing the total number of digitally recorded events in Shumagin network catalog to 5805 since 1982. The seismicity for the first half of 1990 is shown in map view on Figure 2 and in cross section on Figure 3. Events shown by solid symbols are those events that meet the following quality criteria: located by 8 or more P or S arrivals, vertical error from *Hypoinverse* less than 10 km, and horizontal error less than 5 km. Other events are shown by open symbols. These criteria provide a rough indication of the location quality, and show that epicenters more than 100 km from the nearest station are rarely well determined. Additional numerical tests of hypocenter stability show that when the entire network is operating, shallow events west of 166°W, east of 156°W, or seaward of the trench can not be reliably located. Also, depths of shallow earthquakes are only well-determined beneath the Shumagin Islands.

Significant reconfiguration of the network took place in the summer of 1990, in an effort to refocus network research while drastically reducing operating costs (Figure 1). Five short-period instruments were removed, approximately 1/3 of the telemetered network: stations on Sanak Island (SNK); False Pass, Unimak Island (FPS); northern Pavlof Volcano (PN6); a 3-component station at Black Hills, northern Alaska Peninsula (BLH); and Ivanof Bay, in the NE (IVF). At the central station, backup analog equipment was shut down and removed. The remaining network includes primarily stations in the Shumagin Islands proper, where they can be sited as close as possible to the Aleutian interplate thrust, and a few stations monitoring the Pavlof and Dutton Volcanos in conjunction with the Alaska Volcano Observatory.

One significant improvement was made, to upgrade the central station at Sand Point to a continuous digitally-recorded broad-band station. The instrument, a Guralp CMG-4, records ground velocity at periods up to 20 s on 3 components. It is recorded separately from the telemetered network, along with one station on Pavlof Volcano (PVV), at a continuous 20 samples/second. This instrument has provided high-quality records since late July, 1990, which are being used for detailed source and propagation studies (e.g., Figures 4-5).

The overall pattern in Figures 2-3 resembles the long term seismicity. Seismicity is concentrated near the base of the main thrust zone between 35 and 50 km depth, and immediately above it within the overriding plate. Seismicity contours below 30 km depth parallel the volcanic arc, rather than the trench, and become closer to the trench west of the network (Figure 2). Seismicity appears to be sparse where the main thrust zone is shallower than 35 km, between the Shumagin Islands and the trench. Deeper seismicity extends to depths of 200 km. Some locations near 100 km depth on Figure 2 correlate with the lower plane of the double seismic zone seen in long-term seismicity.

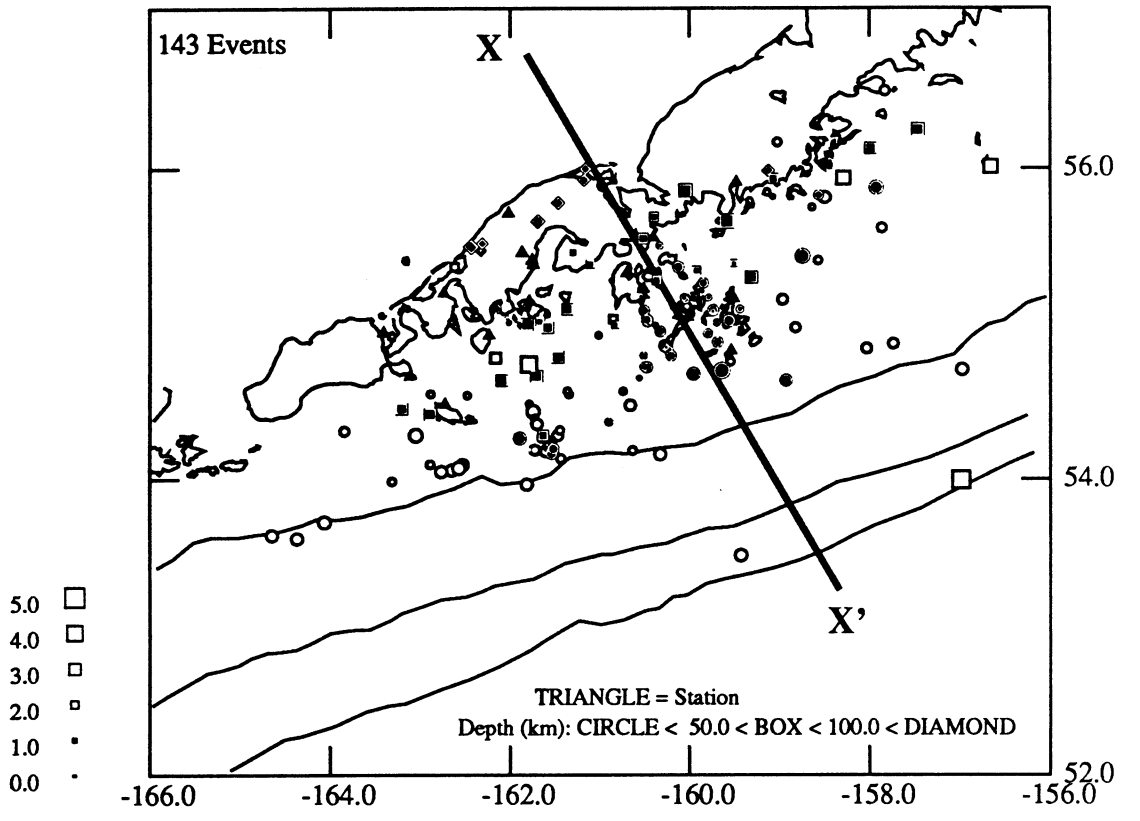

Figure 2. Map of seismicity located by the Shumagin seismic network from July to December, 1990. Symbol shapes show depths, sizes show magnitudes. Filled symbols meet criteria for well-located events, described in text.

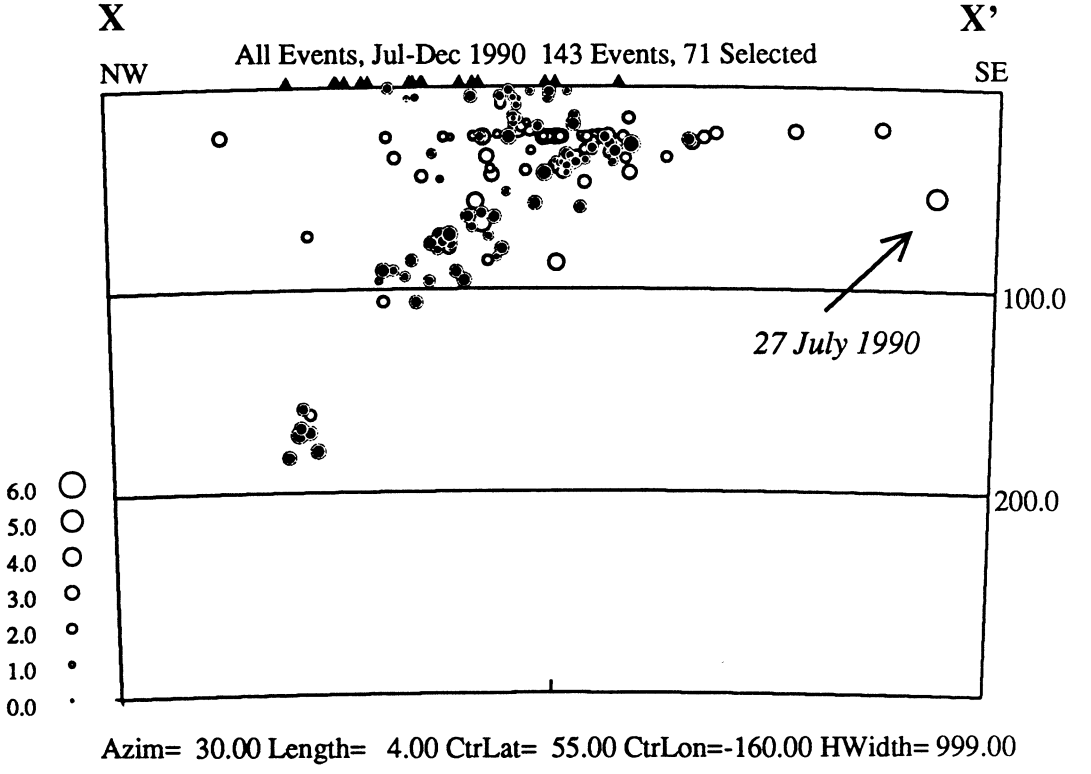

Figure 3. Cross-section of all Shumagin Network seismicity July-December 1990, located in Figure 2.

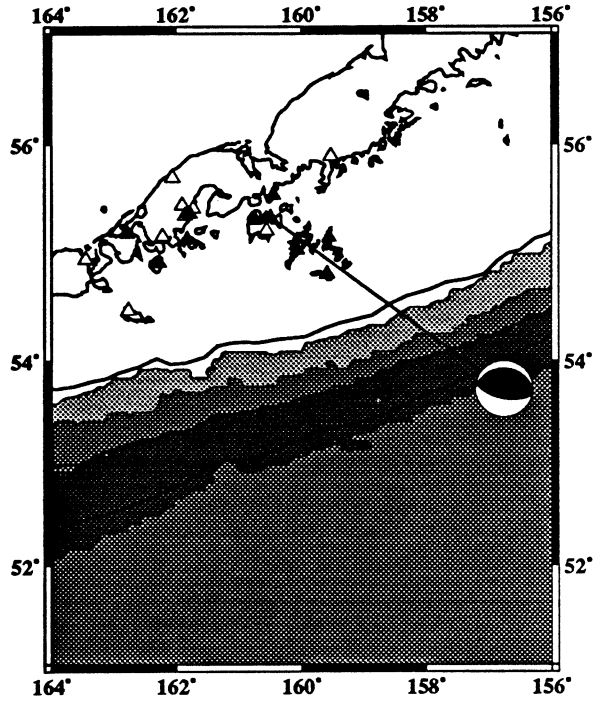

Fig. 4. Location and mechanism of outer-rise event of 7/25/90. Also shown is raypath to broad band station SAI in Sand Point, where seismograms in Fig. 5 are recorded.

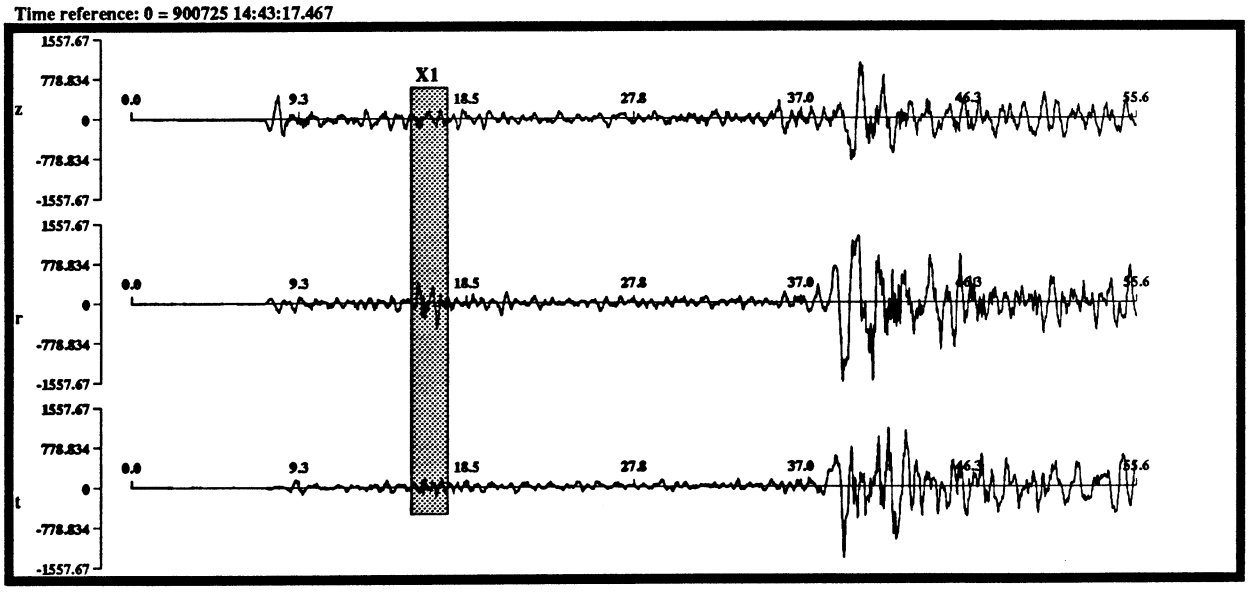

Fig. 5. Broad-band seismograms for outer-rise earthquake of 7/25/90, recorded at Sand Point. Rotated to vertical, radial, and tangential (z,r,t) components. Note strong radial 'X1' phase, tentatively identified as a surface-refracted Sp phase from waveform modelling. Broad-band instrument is flat to velocity between 2.0 and 0.05 Hz.